# International comparisons of mathematics and science performance of 4th-, 8th-, and 12th-grade students

*The technical and scientific skills of a nation's workers are a crucial component of its economic competitiveness. The recently completed Third International Mathematics and Science Study (TIMSS) assessed the mathematics and science performance of students around the world. By comparing the mathematics and science proficiency of 4th-, 8th-, and 12th-graders in six wealthy industrialized countries, it is possible to monitor U.S. progress toward the National Education Goal of being first in the world in mathematics and science achievement.*

- U.S. 4th-graders scored above the 26-nation average in both mathematics and science. In science, only students in Korea outperformed U.S. 4th-graders, while in mathematics, U.S. 4th-graders outperformed their peers in 12 countries and scored below their peers in 7 countries.
- U.S. 8th-graders scored above the 41-nation average in science and below the international average in mathematics. In science, U.S. 8th-graders outperformed their peers in 15 countries and scored below their peers in 9 countries. In mathematics, 8th-graders in 20 countries outperformed U.S. 8th-graders. U.S. 8th-graders had higher scores than their peers in 7 countries.
- U.S. 12th-graders scored below the 21-nation average in both mathematics and science. In science, U.S. 12th-graders scored below students in the last year of secondary school in 11 countries. U.S. 12th-graders outperformed their peers in 2 countries. In mathematics, U.S. students scored below their peers in 14 countries and outperformed their peers in 2 countries.

## Average mathematics proficiency scores, by country, grade, and sex: 1995

| | 4th-grade | | | 8th-grade | | | 12th-grade | | |
|---|---|---|---|---|---|---|---|---|---|
| G-7 country | Total | Boys | Girls | Total | Boys | Girls | Total | Boys | Girls |
| Canada[3] | 532 | 534 | 531 | [4]527 | [4]526 | [4]530 | [4]519 | [4]537 | [4]504 |
| England[1,2] | [5]513 | [5]515 | [5]510 | 506 | 508 | 504 | — | — | — |
| France[3] | — | — | — | [4]538 | [4]542 | [4]536 | [4]523 | [4]544 | [4]506 |
| Germany[2,3] | — | — | — | 509 | 512 | 509 | [4]495 | [4]509 | 480 |
| Italy[3] | — | — | — | — | — | — | 476 | 490 | 464 |
| Japan | [4]597 | [4]601 | [4]593 | [4]605 | [4]609 | [4]600 | — | — | — |
| United States[2] | 545 | 545 | 544 | 500 | 502 | 497 | 461 | 466 | 456 |

## Average science proficiency scores, by country, grade, and sex: 1995

| | 4th-grade | | | 8th-grade | | | 12th-grade | | |
|---|---|---|---|---|---|---|---|---|---|
| G-7 country | Total | Boys | Girls | Total | Boys | Girls | Total | Boys | Girls |
| Canada[3] | [5]549 | [5]553 | [5]545 | 531 | 537 | 525 | [4]532 | [4]550 | [4]518 |
| England[1,2] | [5]551 | [5]555 | 548 | 552 | 562 | 542 | — | — | — |
| France[3] | — | — | — | [5]498 | [5]506 | [5]490 | 487 | 508 | 468 |
| Germany[2,3] | — | — | — | 531 | 542 | 524 | 497 | 514 | 478 |
| Italy[3] | — | — | — | — | — | — | 475 | 495 | 458 |
| Japan | 574 | 580 | 567 | [4]571 | [4]579 | [4]562 | — | — | — |
| United States[3] | 565 | 571 | 560 | 534 | 539 | 530 | 480 | 492 | 469 |

— Not available.

[1] Did not meet international sampling or other guidelines for 4th grade.

[2] Did not meet international sampling or other guidelines for 8th grade.

[3] Did not meet international sampling or other guidelines for 12th grade.

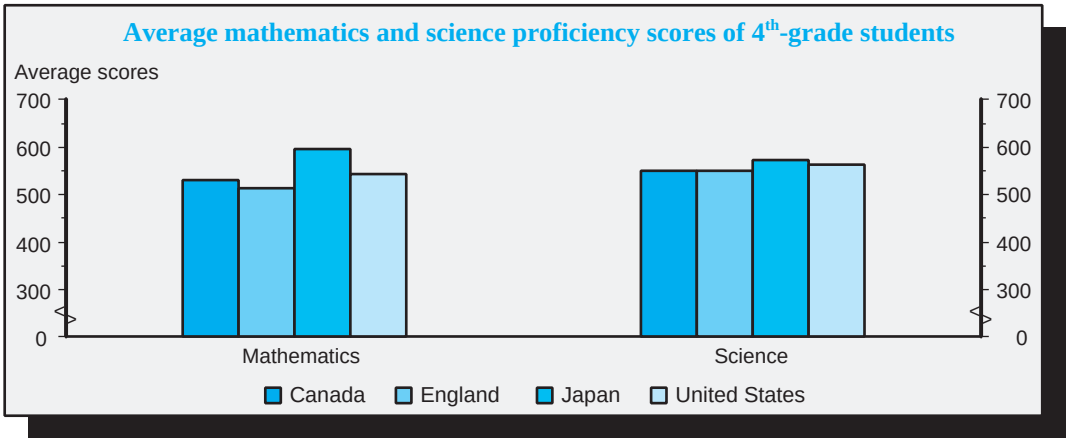
[4] Significantly higher than the United States at the .05 level.

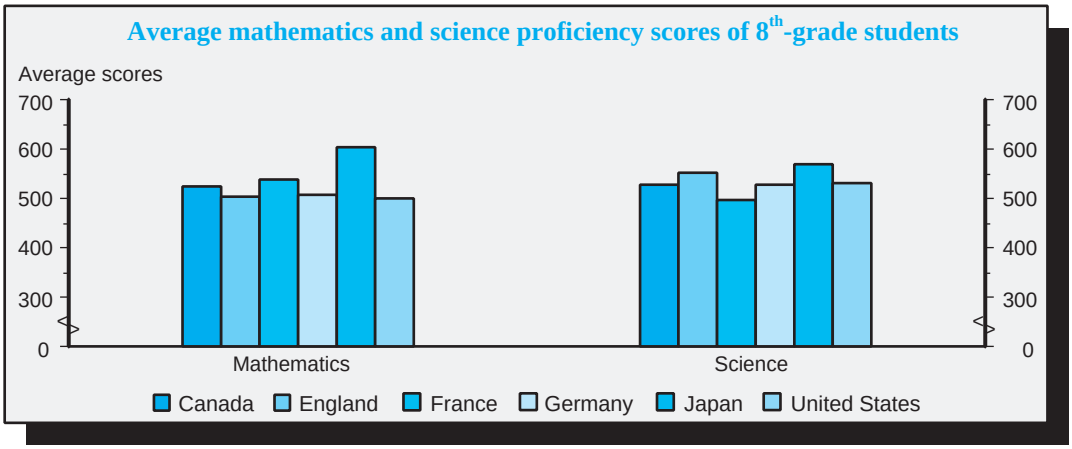
[5] Significantly lower than the United States at the .05 level.

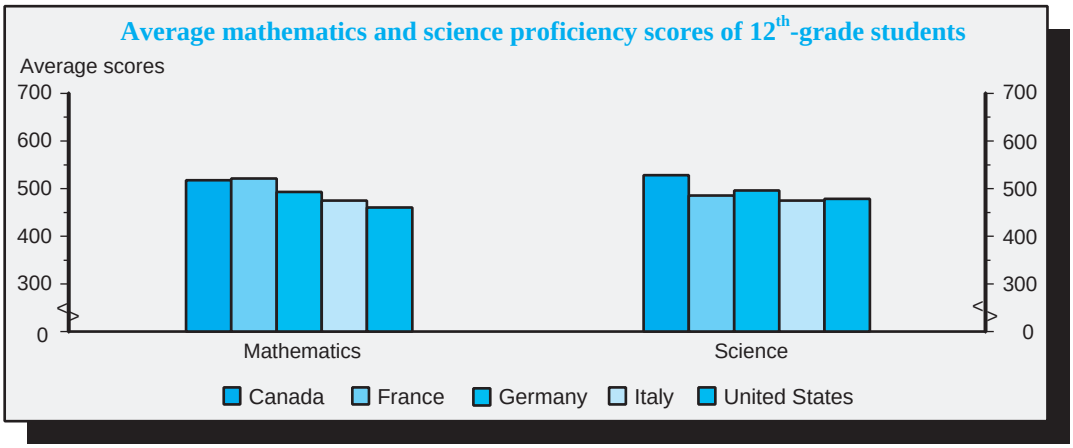
NOTE: Students in their last year of secondary school were assessed in whichever grade was in each country. In most countries, the 12th grade is the last year of secondary school, but in many countries (unlike the U.S.), the last year may be a lower or higher grade. See the supplemental note to this indicator for further explanation on countries that complied or did not comply with various data collection and sampling guidelines. See the glossary for the definition of G-7 countries.

SOURCE: International Association for the Evaluation of Educational Achievement, TIMSS International Study Center, *Mathematics Achievement in the Middle School Years (1996), Science Achievement in the Middle School Years (1996), Mathematics Achievement in the Primary School Years (1997), Science Achievement in the Primary School Years (1997).* U.S. Department of Education, National Center for Education Statistics, *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context,* 1998.

## Average mathematics and science proficiency scores for G-7 countries: 1995




NOTE: Data are not available for 4th-grade students in France, Germany, and Italy; 8th-grade students in Italy; and 12th-grade students in England and Japan.

SOURCE: International Association for the Evaluation of Educational Achievement, TIMSS International Study Center, *Mathematics Achievement in the Middle School Years* (1996), *Science Achievement in the Middle School Years* (1996), *Mathematics Achievement in the Primary School Years* (1997), *Science Achievement in the Primary School Years* (1997). U.S. Department of Education, National Center for Education Statistics, *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*, 1998.

## Note to Indicator 20: Data collection and sampling guidelines for the TIMSS

*Indicators 3, 20, 37*, and *38* all include data from the Third International Mathematics and Science Study (TIMSS), which tested and collected data for more than half a million students at five grade levels, encompassing three separate populations. The indicators in this publication used data from *Population 1* and *Population 2* as defined below:

- *Population 1*: Students enrolled in the two adjacent grades that contained the largest proportion of 9-year-old students at the time of testing (third- and fourth-grade students in most countries).
- *Population 2*: Students enrolled in the two adjacent grades that contained the largest proportion of 13-year-old students at the time of testing (seventh- and eighth-grade students in most countries).
- *Population 3:* Students enrolled in the final year of secondary school, regardless of their type of school or program, so that within the same country students in different grades participated in TIMSS. Across all the countries, students as low as grade 10 and as high as grade 14 participated (in all but one country, 12th-graders constituted part or all of the student sample). General knowledge assessments were administered to a sample of all students and results from these assessments are presented in *Indicator 20*. (Separate assessments in physics and advanced mathematics were given to students who had taken or were taking physics and advanced mathematics, respectively, but those results are not shown here. See *Pursuing Excellence: A Study of Twelfth-Grade Mathematics and Science Achievement in International Context*).

All countries participating in the study were required to administer tests to the students in the two grades at *Population 2*, but could choose whether or not to participate in the tests of other populations. Over forty countries participated in the survey, of which 14 participated in *Populations 1, 2,* and *3*.

Additional countries were either unable to complete the steps necessary for data to appear in the TIMSS report, chose not to release their results in the report, or had their results published in a separate appendix to the report. Data for these countries, therefore, have not been included in this volume.

For all of three *Populations*, participants were required to meet various sampling guidelines. These guidelines, and the extent to which countries met them for *Populations 1* and *2*, are described in the following sections. (See *Pursuing Excellence: A Study of Twelfth-Grade Mathematics and Science Achievement in International Context*, Appendix A, for details about *Population 3*).

**Table 1. Countries participating in the TIMSS, by population covered**

| Country | Population 1 | Population 2 | Population 3 |
|---|---|---|---|
| Australia | ✓ | ✓ | ✓ |
| Austria | ✓ | ✓ | ✓ |
| Belgium (Fl) | | ✓ | |
| Belgium (Fr) | | ✓ | |
| Bulgaria | | ✓ | |
| Canada | ✓ | ✓ | ✓ |
| Colombia | | ✓ | |
| Cyprus | ✓ | ✓ | ✓ |
| Czech Republic | ✓ | ✓ | ✓ |
| Denmark | | ✓ | ✓ |
| England | ✓ | ✓ | |
| France | | ✓ | ✓ |
| Germany | | ✓ | ✓ |
| Greece | ✓ | ✓ | ✓ |
| Hong Kong | ✓ | ✓ | |
| Hungary | ✓ | ✓ | ✓ |
| Iceland | ✓ | ✓ | ✓ |
| Iran, Islamic Republic | ✓ | ✓ | |
| Ireland | ✓ | ✓ | |
| Israel | ✓ | ✓ | |
| Italy | ✓ | ✓ | ✓ |
| Japan | ✓ | ✓ | |
| Korea | ✓ | ✓ | |
| Kuwait | ✓ | ✓ | |
| Latvia | ✓ | ✓ | ✓ |
| Lithuania | | ✓ | ✓ |
| Netherlands | ✓ | ✓ | ✓ |
| New Zealand | ✓ | ✓ | ✓ |
| Norway | ✓ | ✓ | ✓ |
| Portugal | ✓ | ✓ | |
| Romania | | ✓ | |
| Russian Federation | | ✓ | ✓ |
| Scotland | ✓ | ✓ | |
| Singapore | ✓ | ✓ | |
| Slovak Republic | | ✓ | |
| Slovenia | ✓ | ✓ | ✓ |
| South Africa | | ✓ | |
| Spain | | ✓ | ✓ |
| Sweden | | ✓ | ✓ |
| Switzerland | | ✓ | ✓ |
| Thailand | ✓ | ✓ | |
| United States | ✓ | ✓ | ✓ |

### Population 1: Third- and Fourth-Grade Students

In some situations, where it was not possible to implement testing for the entire International Desired Population (*Population 1*), countries were

**Table 2. Countries covering less than 100 percent of the International Desired Population for *Population 1***

| | International Desired Population | |
|---|---|---|
| Country | Coverage | Note on Coverage |
| Israel | 72% | Hebrew Public Education System only |
| Latvia | 60% | Latvian-speaking schools only |

permitted to define a National Desired Population, which excluded some portion of the International Desired Population. For example, Israel and Latvia's populations covered less than 100 percent of the International Desired Population because they needed to define their population according to the structure of school systems.

Countries were also permitted to, within their desired population, define a population that excluded a small percentage (less than 10 percent) of schools or students that would be difficult to test (e.g., very small schools or schools located in a remote area). England was the only country that exceeded the 10 percent level, excluding 12.1 percent of schools from the desired population.

**Table 3. Countries that participated in *Population 1* of the TIMSS, by compliance with sampling guidelines**

| Compliance with Sampling Guidelines | Countries |
|---|---|
| Countries satisfying guidelines for sample participation rates, grade selection, and sampling procedures | Canada<br>Cyprus<br>Czech Republic<br>Greece<br>Hong Kong<br>Iceland<br>Iran, Islamic Republic<br>Ireland<br>Japan<br>Korea<br>New Zealand<br>Norway<br>Portugal<br>Scotland<br>Singapore<br>United States |
| Countries not satisfying guidelines for sample participation rates | Australia<br>Austria<br>England<br>Latvia<br>Netherlands |
| Countries not meeting age/grade specifications | Slovenia |
| Countries with unapproved sampling procedures at the classroom level | Hungary<br>Israel<br>Kuwait<br>Thailand |

The TIMSS used a two-stage sample design, in which the first stage involved selecting 150 public and private schools within each country. Random sampling methods were then used to select from each school one mathematics class for each grade level (third and fourth). The required participation rates from the samples were at least 85 percent of both schools and students, or a combined rate of 75 percent.

England and Scotland met sampling guidelines only after including replacement schools for those schools refusing or unable to participate. Australia, Austria, Latvia, and the Netherlands failed to meet sampling participation standards. These countries either did not reach a 50 percent participation rate without the inclusion of replacement schools, or failed to reach the required rate even with the inclusion of replacement schools.

Slovenia chose to test their third- and fourth-grade students even though these were not the two adjacent grade levels with the highest proportion of 9-year-olds. Although this was done in order to increase the similarity of curricula, it resulted in their students being somewhat older than the students from other countries who participated in the study.

Hungary, Israel, Kuwait, and Thailand, for various reasons, had difficulty complying with guidelines for sampling classrooms. For example, Kuwait tested a single grade with relatively few 9-year-olds, Israel had low sampling participation rates, and Thailand had a high percentage of older students.

### Population 2: Seventh- and Eighth-Grade Students

As was the case in *Population 1*, in some situations where it was not possible to implement testing for the entire International Desired Population (*Population 2*), countries were permitted to define a National Desired Population, which excluded some

**Table 4. Countries covering less than 100 percent of the International Desired Population for *Population 2***

| | International Desired Population | |
|---|---|---|
| Country | Coverage | Note on Coverage |
| Germany | 0.88 | 15 of 16 regions |
| Israel | 0.74 | Hebrew Public Education System only |
| Latvia | 0.51 | Latvian-speaking schools only |
| Lithuania | 0.84 | Lithuanian-speaking schools only |
| Switzerland | 0.86 | 22 of 26 cantons |

portion of the International Desired Population. For example, Israel, Latvia, and Lithuania's populations covered less than 100 percent of the International Desired Population because they needed to define their population according to the structure of school systems. In the case of Germany and Switzerland, however, some regions simply did not wish to participate in the study.

Countries were also permitted to, within their desired population, define a population that excluded a small percentage (less than 10 percent) of schools or students that would be difficult to test (e.g., very small schools or schools located in a remote area). England was the only country that exceeded the 10 percent level, excluding 11.3 percent of schools from the desired population.

The TIMSS used a two-stage sample design, in which the first stage involved selecting 150 public and private schools within each country. Random sampling methods were then used to select from each school one mathematics class for each grade level (seventh and eighth). The required participation rates from the samples were at least 85 percent of both schools and students, or a combined rate of 75 percent.

Belgium (Fl), England, Germany, and the United States met sampling guidelines only after including replacement schools for those schools refusing or unable to participate. Australia, Austria, Belgium (Fr), Bulgaria, the Netherlands, and Scotland failed to meet sampling participation standards. These countries either did not reach a 50 percent participation rate without the inclusion of replacement schools, or failed to reach the required rate even with the inclusion of replacement schools.

Four countries (Colombia, Germany, Romania, and Slovenia) chose to test their seventh- and eighth-grade students even though these were not the two adjacent grade levels with the highest proportion of 13-year-olds. Although this was done in order to increase the similarity of curricula, it resulted in their students being somewhat older than the students from other countries who participated in the study.

Denmark, Greece, Israel, Kuwait, South Africa, and Thailand, for various reasons, had difficulty complying with guidelines for sampling classrooms. Kuwait tested a single grade with relatively few 13-year-olds, and South Africa and Thailand had low sampling participation rates, contributing to additional difficulties.

**Table 5. Countries that participated in *Population 2* of the TIMSS, by compliance with sampling guidelines**

| Compliance with Sampling Guidelines | Countries |
|---|---|
| Countries satisfying guidelines for sample participation rates, grade selection, and sampling procedures | Canada<br>Cyprus<br>Czech Republic<br>France<br>Hong Kong<br>Hungary<br>Iceland<br>Iran, Islamic Republic<br>Ireland<br>Japan<br>Korea<br>Latvia<br>Lithuania<br>New Zealand<br>Norway<br>Portugal<br>Russian Federation<br>Singapore<br>Slovak Republic<br>Spain<br>Sweden |
| Countries not satisfying guidelines for sample participation rates | Australia<br>Austria<br>Belgium (Fr)<br>Bulgaria<br>England<br>Germany<br>Israel<br>Latvia<br>Lithuania<br>Netherlands<br>Scotland<br>Switzerland |
| Countries not meeting age/grade specifications | Colombia<br>Germany<br>Romania<br>Slovenia |
| Countries with unapproved sampling procedures at the classroom level | Denmark<br>Greece<br>Israel<br>Kuwait<br>South Africa<br>Thailand |

SOURCE: International Association for the Evaluation of Educational Achievement, TIMSS International Study Center, *Mathematics Achievement in the Middle School Years*, *Science Achievement in the Middle School Years*, *IEA's Third International Mathematics and Science Study (TIMSS)*, 1996; *Mathematics Achievement in the Primary School Years*, *Science Achievement in the Primary School Years*, *IEA's Third International Mathematics and Science Study (TIMSS)*, 1997.

## Table S20(a) Standard errors for the first text table in *Indicator 20*

| G-7 country | 4th-grade | | | 8th-grade | | | 12th-grade | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Boys | Girls | Total | Boys | Girls | Total | Boys | Girls |
| Canada | 3.3 | 3.4 | 3.9 | 2.4 | 3.2 | 2.7 | 2.8 | 3.8 | 3.5 |
| England | 3.2 | 3.4 | 4.4 | 2.6 | 5.1 | 3.5 | — | — | — |
| France | — | — | — | 2.9 | 3.1 | 3.8 | 5.1 | 5.6 | 5.3 |
| Germany | — | — | — | 4.5 | 5.1 | 5.0 | 5.9 | 8.8 | 8.8 |
| Italy | — | — | — | — | — | — | 5.5 | 7.4 | 6.0 |
| Japan | 2.1 | 2.5 | 2.2 | 1.9 | 2.6 | 2.1 | — | — | — |
| United States | 3.0 | 3.1 | 3.3 | 4.6 | 5.2 | 4.5 | 3.2 | 4.1 | 3.6 |

SOURCE: International Association for the Evaluation of Educational Achievement, TIMSS International Study Center, *Mathematics Achievement in the Middle School Years* (1996), *Science Achievement in the Middle School Years* (1996), *Mathematics Achievement in the Primary School Years* (1997), *Science Achievement in the Primary School Years* (1997). U.S. Department of Education, National Center for Education Statistics, *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context,* 1998.

## Table S20(b) Standard errors for the second text table in *Indicator 20*

| G-7 country | 4th-grade | | | 8th-grade | | | 12th-grade | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Boys | Girls | Total | Boys | Girls | Total | Boys | Girls |
| Canada | 3.0 | 3.7 | 3.2 | 2.6 | 3.1 | 3.7 | 2.6 | 3.6 | 3.8 |
| England | 3.3 | 4.0 | 3.4 | 3.3 | 5.6 | 4.2 | — | — | — |
| France | — | — | — | 2.5 | 2.7 | 3.3 | 5.1 | 6.7 | 4.8 |
| Germany | — | — | — | 4.8 | 5.9 | 4.9 | 5.1 | 7.9 | 8.5 |
| Italy | — | — | — | — | — | — | 5.3 | 6.7 | 5.6 |
| Japan | 1.8 | 2.0 | 2.0 | 1.6 | 2.4 | 2.0 | — | — | — |
| United States | 3.1 | 3.3 | 3.3 | 4.7 | 4.9 | 5.2 | 3.3 | 4.6 | 3.9 |

SOURCE: International Association for the Evaluation of Educational Achievement, TIMSS International Study Center, *Mathematics Achievement in the Middle School Years* (1996), *Science Achievement in the Middle School Years* (1996), *Mathematics Achievement in the Primary School Years* (1997), *Science Achievement in the Primary School Years* (1997). U.S. Department of Education, National Center for Education Statistics, *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context,* 1998.